SEASONAL ACTIVITY PATTERN OF COLUMBIAN GROUND SQUIRRELS IN THE IDAHO PRIMITIVE AREA

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Abstract.— Data were gathered concerning the seasonal activity pattern of a population of Columbian ground squirrels (*Spermophilus columbianus*) in the Idaho Primitive Area. Adult females were significantly more active in June of all years than were adult males. A relationship between ground squirrel activity and temperature is postulated in which the squirrels alter their activity so as to avoid high temperatures and possible heat stress.

Members of the genus *Spermophilus* are characterized by a seasonally short period of aboveground activity and a prolonged period of hibernation. During this time of surface activity ground squirrels must establish territories, breed, reproduce, and gain sufficient weight to survive the inactive season. The annual cycle of activity for various species of ground squirrels has been reported (Skryja and Clark 1970, Michener 1974, Loehr and Risser 1977), but these data as they apply to populations of Columbian ground squirrels (*Spermophilus columbianus*) are limited.

Methods

The study was conducted at Cold Meadows, an 87 ha meadow (elev. 2010 m) located in the northeastern portion of the Big Creek Ranger District, Idaho Primitive Area. A description of the Big Creek area has appeared elsewhere (Wing 1969, Hornocker 1970, Seidensticker et al. 1973). Ground squirrels were trapped from 12–19 June, 17–24 July, and 14–21 August, 1976–1978. Field work prior to 12 June was impractical because of bad weather and the inaccessibility of the study area. A 90 x 90 m grid with 36 trapping stations 15 m apart was established on the central portion of the meadow. One live trap (15 x 15 x 48 cm) was placed at each trapping station. Traps were baited with carrot and checked every hour. Captured squirrels were marked using the toe clipping sequence of Melchior and Iwen (1965), sexed, measured, weighed, time-of-capture recorded, and released back onto the grid. Vegetation was collected using the procedure outlined by Tadmor et al. (1975). All plant samples were weighed to the nearest gram in the field and then brought back to the laboratory, where they were oven dried at 64 C for three days. The dried specimens were then weighed to the nearest gram and percent moisture content calculated. Daily ambient temperatures were obtained using a Taylor Maximum-Minimum thermometer.

Ground squirrel activity in this study was equated with the animals presence in the traps. Bias due to 'trap-shy' or 'trap-happy' squirrels may have occurred, but attempts to conduct hourly visual censuses proved unreliable during the latter months due to the increase in vegetation height.

Results and Discussion

The number of Columbian ground squirrels captured, including recaptures, is depicted in Table 1. Adult female squirrels were significantly more active in June of each year than were adult males (Kolmogorov-Smirnov Two Sample Test, $P < 0.05$). Activity for July and August was not significantly different between sexes of adult or young squirrels.

Males are territorial during the breeding season (Steiner 1970a), exhibiting extreme aggression toward other males and occasionally raiding the nesting ground and colonies of adjacent males (Steiner 1970a, 1970b, 1971,

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1972). This aggressive behavior and Lambeth's (1977) findings that Columbian ground squirrels utilize a core area or arena of activity between 21 and 40 m in size may account for the greater number of females captured in June. Dominant males would have been excluding other male squirrels from the trapping grid.

The hibernation entry sequence described by Manville (1959) and Michener (1974) for *S. columbianus* was not apparent for the Cold Meadows colony. This disparity may be artificial because adult ground squirrels during August become very lethargic and inactive and were extremely difficult to trap.

Shaw (1925) has suggested that early spring activities of Columbian ground squirrels are largely controlled by temperature alone, whereas estivation is induced by the drying of the vegetation. Howell (1938) felt that "the date of beginning estivation was determined chiefly by the ripening of the vegetation and consequent reduction of the moisture content in their (ground squirrels) food, and in part also by the accumulation of fat in the body." Nansel and Knoche (1972) also observed Columbian ground squirrels and postulated that hibernation was a response to drought prior to a decrease in temperature. Cold Meadows plant moisture content declined as the season progressed (Table 2), as did the squirrels' aboveground activity (Table 1).

Peak daily activity of ground squirrels at Cold Meadows appears to be determined by temperature. Table 3 shows the monthly time interval exhibiting the greatest percentage of adult ground squirrel activity. The mean maximum temperature for June 1976 (Table 4) was significantly greater than June 1977 and June 1978. The maximum percent of activity for June 1976 occurs later in the day than for June 1977 or June 1978. This same type of activity shift in relation to significantly greater maximum temperatures is evident for July; July 1978 is significantly greater

TABLE 1. Live trapping results by age and sex for Columbian ground squirrels at Cold Meadows, Idaho Primitive Area, 1976–1978.

	June		July				August			
	Adult		Adult		Juvenile		Adult		Juvenile	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1976	12	25	15	32	15	13	5	5	13	5
1977	15	39	7	12	11	8	3	2	2	4
1978	24	32	18	13	6	7	2	6	7	6

TABLE 2. Mean percent moisture content (± standard deviation) of plant species exhibiting the highest frequency of occurrence at Cold Meadows, Idaho Primitive Area, 1976–1978.

	1976		1977			1978		
Species[1]	July	August	June	July	August	June	July	August
Achillea millefolium	66 ± 1	72 ± 4	72 ± 1	72 ± 5	58 ± 1	82 ± 3	77 ± 2	60 ± 4
Carex aquatilis	65 ± 5	63 ± 6	61 ± 7	51 ± 4	30 ± 1	67 ± 2	58 ± 3	45 ± 5
Fragaria virginiana	67 ± 8	66 ± 2	65 ± 8	65 ± 7	52 ± 1	76 ± 1	67 ± 2	55 ± 1
Penstemon procerus	68 ± 6	65 ± 2	72 ± 3	66 ± 5	47 ± 1	73 ± 1	69 ± 2	63 ± 2
Phleum alpinum	63 ± 5	57 ± 7	57 ± 1	49 ± 8	27 ± 1	72 ± 2	59 ± 4	30 ± 1

1: n = 10 samples/species/month.

TABLE 3. Peak activity time intervals for adult Columbian ground squirrels at Cold Meadows, Idaho Primitive Area, 1976–1978.

	1976	1977	1978
June 12–19	1700–1800 hours	1400–1500	1400–1500
July 17–24	1300–1400	1200–1300	1000–1100
August 14–21	1600–1700	1200–1300	1300–1400

TABLE 4. Monthly mean maximum temperatures (±standard deviation) at Cold Meadows, Idaho Primitive Area, 1976–1978.

	1976	1977	1978
June 12–19	22 ± 2 C[1]	20 ± 2^{1}	20 ± 2^{1}
July 17–24	22 ± 1^{2}	$22 \pm 1^{1,2}$	$24 \pm 1^{1,2}$
August 14–21	$17 \pm 2^{1,2}$	25 ± 1^{2}	$17 \pm 2^{1,2}$

1: Means tested for significance using unpaired t-test at the 0.05 level.
2: Means tested for significance using Cochran and Cox test at the 0.05 level (Ferguson 1959:143).

than July 1976 and July 1977. August 1977 mean daily maximum temperature is significantly greater than August 1976 and August 1978; yet the expected shift in peak activity does not occur. This may be due to the small activity sample size for August 1977.

The relationship of temperature to activity indicates that the higher the average daily maximum temperature, the earlier or later in the day peak activity will occur. If this hypothesis is valid, then, for those sampling periods where the average maximum temperatures were not significantly different, the time interval of peak activity should be similar. This relationship is observed for June 1977 and June 1978, and July 1976 and July 1977 (Table 3).

Betts (1976) observed a lower elevation (1360 m) colony of *S. columbianus* in western Montana and reported that, with the increase in temperatures during lactation and postlactation periods, there was an increase in morning and late afternoon activity and a decrease in midday activity. Betts postulated that temperature or solar radiation may limit the amount of consecutive time Columbian ground squirrels can spent aboveground.

The observations of Betts (1976) and data reported here indicate that the scheduling of surface activity for these squirrels is an apparent behavioral response designed to escape heat stress.

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